

(19) 日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11) 特許出願公開番号

特開平6-205751

(43) 公開日 平成6年(1994)7月26日

(51) Int.Cl. <sup>5</sup>	識別記号	庁内整理番号	F I	技術表示箇所
A 6 1 B 5/0452		7638-4C	A 6 1 B 5/04	3 1 2 C

審査請求 有 発明の数 1 F D (全 12 頁)

(21) 出願番号 特願平5-323090  
 (62) 分割の表示 特願昭61-30739の分割  
 (22) 出願日 昭和61年(1986)2月17日

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(54) 【発明の名称】 心臓電位の記録装置

(57) 【要約】

【目的】 心電計を使用することなく、心臓の機能を視覚的、直観的に把握することができると共に一般の人にも説明し易く、理解しやすい心臓電位の記録装置を提供する。

【構成】 胸部の各誘導部位に装着し、心臓の電位を誘導する電極と、該電極により取り込まれたアナログ信号をデジタル信号に変換するインターフェース装置と、該デジタル信号を取り込み測定データの演算を行い、基準値との偏差を心臓図に解析表示するパーソナルコンピュータとからなる心臓電位の記録装置。

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Japanese Laid-open Patent Application (KOKAI) H06-205751

**【TITLE OF THE INVENTION】** A Recording Device of Cardiac Potential

**【CLAIM】**

**【Claim 1】**

A recording device of cardiac potential comprising:  
electrodes attached to each of lead parts and an inducting cardiac potential;  
an interface device converting analog signals into digital signals; and  
a personal computer for performing fetch of the digital signals and  
calculation of measurement data, and carrying out analytical expression of  
variation from a benchmark into a cardiogram.

**【DETAILED DESCRIPTION OF THE INVENTION】**

**【0001】**

**【Field of the invention】** This invention relates to a recording device of cardiac potential, more specifically to a cardiac potential recording device by which functions of heart can easily be recognized visually and intuitively by displaying electrical activities (cardiac potential) of the heart in different colors.

**【0002】**

**【Conventional art】** Conventionally, functions of heart are recorded using a cardiograph, a judgment is carried out by subjecting recorded data for analysis.

**【0003】** It is widely known that cardiograms are useful record to recognize function of the heart. Cardiograms display the heart's electrical activity, which include excited condition in the heart and relief thereof. Such electrical activity is indicated by waves such as P waves, QRS complex, and T

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waves so on. Thereafter, mechanical excitement of an atrium and the ventricle, that is, contraction and expansion of an atrium and the ventricle occur. The waves displayed on a cardiogram are electrical tracking of excited condition in the heart and relief thereof that is necessary to cause the heart's activity.

【0004】 Conventionally, cardiograms are usually recorded on a longitudinal grid paper underlined (graph with scales, the minimum unit of a scale is a length of 1mm, and a small quadrangle with a height of 1mm, Between thick lines, the small quadrangle is contained by five-piece square ) by a cardiograph in a width of 2.5 cm/sec. Medical staffs recognize cardiac beats rate, tuning, hypertrophy of axis, a heart muscle obstacle, and infraction by measuring a width (millisecond) and height (amplitude mV) of each of P waves, QRS complex ST waves and T waves.

【0005】

【Problem to be solved】 All the pages should be examined in order to recognize the above-mentioned health problems from a recorded cardiogram, however, it takes certain period of time to read all the wave forms recorded on the paper. There are two fatal problems such as, some parts that represent overall characteristic of the wave forms are read, but skill is required to read the characteristic and a quantized judgment can not easily be carried out because the degree of skill varies with individuals. In addition, analysis of a cardiogram is difficult even for specialists. Moreover, it is much more difficult to explain what the waves on a cardiogram represent for to an ordinarily person.

【0006】 The present invention is completed as a result of studying the above stated problems. It is an aim of the present invention to provide a

recording device of cardiac potential by which functions of the heart can easily be recognized visually and intuitively as well as easily be explained to ordinarily people by displaying a result of analysis on signals obtained from electrodes disposed on measuring points of patient's chest on a CRT of a PC.

【0007】

**【Means for solving the problem】** In other words, the present invention is a recording device of cardiac potential comprising: electrodes attached to each of lead parts and an inducting cardiac potentials; an interface device converting analog signals into digital signals; and a personal computer for performing fetch of the digital signals and calculation of measurement data, and carrying out analytical expression of variation from a benchmark into a cardiogram.

【0008】 Details of the present invention will be described below. The recording device of cardiac potential according to the present invention carries out the following steps such as: sending 12 biological signals input from electrodes to the personal computer via an interface device and performing analysis of the signal; and automatically recording waveforms of the cardiac potential from results of the analysis.

【0009】 Fig. 1 is a block diagram showing an example of a recording device of cardiac potential according to the present invention. In Fig. 1, the electrodes induce biological potential, and signals thus induced are fetched to the interface device as analog signals.

【0010】 The electrodes are disposed with conventional 12 leads comprising 6 of limb leads and 6 of chest leads. Such electrodes may be commercially available ones. For example, electrodes for electrocardiogram measurement may be used. Subsequently, electrodes are attached to

measuring parts of the chest, and connect them to a personal computer via the interface device shown in Fig. 1.

[0011] A device for eliminating noise, for instance, preamplifier and the like may be provided between the electrodes and the interface device when noise is mixed in the signals induced from the electrodes.

[0012] In the present invention, the interface device functions for converting analog signals displayed using the electrodes into digital signals and for sending the converted signals to the personal computer. Such interface device comprises a 12CH multiplexer, a preamplifier, a 12bit A/D converter, an intelligent control unit, an RS232 C unit and son on.

[0013] The 12CH multiplexer is a device of fetching analog signals from the electrodes by switching inputs of 12 channels into each input for each channel. The switching period the device is 50 macro-seconds.

[0014] The preamplifier amplifies signals fetched by the 12CH multiplexer. The 12bit A/D converter (A/D converter) converts analog signals obtained from the preamplifier into digital signals. .

[0015] The intelligent control unit(data collect control device) controls 12CH multiplexer to switch channel for activating the A/D converter, fetching data for 12 channels, and controls the RS232C unit to send the data to the personal computer (PANAFACOM C-7000D).

[0016] The RS232C unit is an interface based on Recommended Standard 232 version C, and a connector connecting the interface device and the personal computer.

[0017] Subsequently, an example of specification for the interface device is as follows:

Input channel	12 channels
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Input impedance	100 K $\Omega$
A/D conversion time	200 $\mu$ /sec.
A/D conversion accuracy	12 bits.

【0018】 Fig. 2 shows a circuit diagram of the interface device. Fig. 3 shows a diagrammatic example of the control unit of the analog/digital converter. Specification of the unit is as follows:

CPU	: 8086- 2.8MHz (16 bit)
ROM	: 96 K Byte
RAM	: 640K Byte (Main memory)
FDD	: 5 Inch 6.4MB X 2
ADC	: 12 bit input $\pm$ 250mV.

【0019】 In this invention, the personal computer is connected with the interface device. Such computer performs a calculation of the measured data sent from the interface device and performs analysis and display of a deviation of a measurement value and a reference value. The way of performing analysis and display on a cardiogram is that display according to color, shade of a color, noughts-and-crosses, dots and some other can be employed, among these, however, display according to color is most preferable.

【0020】 The personal computer comprises a computer body, a color display, a keyboard, a 10MB fixed disk device and a printer so on. A practical example of a personal computer is OA personal computer C-70000D in which memory of 256KB ~ 384 KB is equipped.

【0021】 Subsequently, the specification of the personal computer used for the present invention will be shown as below.

○Computer body

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Memory capacity : R O M 8 Kbytes  
: R A M 3 8 4 Kbytes  
Color CRT output : 640 X 480 dots  
Palette function : 8 color simultaneous display  
Printer output : 24 X 24 dots 120 CPS  
Calendar clock : built-in  
Power source : AC100V  $\pm$  10%  
Power consumption : 0.9 KVA  
Weight : 23 Kg  
Size : width 480mm X depth 445mm X height 165mm

### 【0022】 ○Color display

CRT : 12 inch.  
Display color : three primary colors, 8 colors, 83 colors including neutral colors  
Screen composition : graphic screen X 9 + character screen  
Power source : AC100V  $\pm$  10%  
Power consumption : 90 KVA or below  
Weight : 12 Kg  
Size : width 320mm X depth 415mm X height 347mm  
: with a tilt table

Number of display character: 80characters X 24 linesX9screens

### 【0023】 ○key board

Key arrangement : standard JIS (ten key)  
Output data : JIS 8 bit-code (parallel)  
Weight : 2.3 Kg

○ 10MB fix disk device

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Memory capacity : 10MB

Data volume : 1000 people

【0024】 ○Printer

Printing speed : 80characters/second

Printing method : dot matrix impact bidirectional printing

Number of printable character: 80 characters/line, 66lines/page

Power source : AC100V  $\pm$  10%

Power consumption : 120VA

Weight : 16 Kg

Size : width 570mm X depth 455mm X height 175mm

Recording of cardiograph potential is carried out with the recording device shown in Fig. 1.

【0025】 Subsequently, a method of recording cardiograph potential using the cardiac potential recording device will be described. Fig, 4 is a flow chart showing a method of recording cardiograph potential. In the Fig. 4, 12CH biological channel input through electrodes for detecting cardiograph potential are fetched into a personal computer via an interface device.

【0026】 Measurement conditions are set as approximately 5 seconds for each measurement period at fixed positions (4.88ms X 1024), and a range of measurement time as 1 through 16 times. Next, measurement data is stored into the main memory of the personal computer C-7000D from the electrodes via the interface device in real time basis after setting measurement time. At the same time, calculation is carried out.

【0027】 Such calculation is performed by converting the above mentioned measurement data (data in time series) into complex Fourier series using fast Fourier transformation (FFT) so that a calculated value is obtained. (see



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table 4 and table 5 both described later)

Number of channel : 12 channels

Sampling clock : 4.8ms

Number of sampling : 1024 points/channels

[0028] Process for selecting measurement wave (single beat) of each lead (12 leads) from the calculated value thus obtained is performed for a predetermined times. Selecting conditions for measured waves is set so that the third beat (the third wave) from the beginning of acquired waves become the wave to be measured, however, if a waveform different from the third beat exists, such waveform becomes the wave to be measured.

[0029] Subsequently, a waveform of one beat out of the 12 leads is displayed and measured. This measured value is written to a measured value master-file. Such measured value master-file is displayed on the CRT by reading the file and specifying a number from a menu screen read in, and hardcopy is carried out to a printer and it prints.

[0030] The measured values obtained from the subject being examined are compared with a reference value of the Minnesota code, and diagnosis such as cardiac beats rate, tuning, hypertrophy of axis, a heart muscle obstacle inflammatory infraction, myocardial dysfunction and comments is displayed and its deviation is shown on a cardiogram in color. In this way, partial functions of the heart can be recognized visually and intuitively and applicable these to diagnosis and medical treatment.

[0031]

**[Embodiment of the invention]** Subsequently, some embodiments are shown and more particular embodiments are described.

[0032] A first embodiment

Record of cardio potential performed under the processing procedure illustrated in tables. 1 and 2 is carried out with a device in which terminals of off-the-shelf electrodes connected to the interface and such interface device is connected to the personal computer (National Pana-Facom C-7000D).

[0033] Table 3 shows brief overview of numbers assigned to the menu.

[0034]

[table 1]

[0035]

[table 2]

[0036]

[table 3]

[0037] [processing procedure]

○ Registration of a subject being examined

Number of the subject being examined, NAME, BIRTH DAY, F or M is recorded on a flexible disk by selecting Menu No.1 and then input these parameters. In another menu, NAME, AGE, F or M are automatically displayed once the number of the subject is input.

[0038] ○ Starting display of subject's data and retrieval thereof

Upon specifying menu No. 2 and input of DATA INPUT OK Y/N Y, retrieval starts. The time duration of retrieval can be set under a desired number of counts. If, retrieval of 1 COUNT (1second) is suspended during which, STOP KEY is pushed, and Y is inputted again and it resumes.

[0039] ○ Display in original wave forms of 12 leads

Specification of menu No. 3 displays a screen showing waveforms. Original waveforms of the first count (5 seconds) in 12 leads are automatically displayed whenever a designated count number of retrieval is completed.

6~ 10 seconds will be displayed if the display of the designated count number of retrieval changes a count 6-1 into 2. Range of the count number is 1 ~ 6 COUNTS (30 seconds).

【0040】

Although, a setup of calculation waveforms is analyzed using the 3rd beat of each of the guides (1~V6) from the first display waveform being made into the subject's standard waveform, and the 3rd beat of each guidance is analyzed as a person's standard wave from the right and the first display waveform, if a standard has an unusual wave more during Setup COUNT, the unusual wave will be displayed and analyzed, if unusual waveforms from the standard waveform are found during setting counts. "Limb (lead from limb)" and "Chest (lead from chest)" in Menu No. 3 can be selected and displayed.

【0041】 ○ calculation waveform display

When Menu No. 4 is selected, 12 leads of calculation waveforms (1 beat) are simultaneously displayed. Then, a calculation starts at a step of DATA OK (Y/N) Y. After completion of such calculation, limb part (LIMD) chest part (CIEST) can be selected and displayed in enlarged manner. "Chest (lead from chest)" and "Limb (lead from limb)" in Menu No. 4 can be selected and displayed.

【0042】 ○ calculation result display

When Menu No. 5 is selected, resulting display that compares measuring values and the reference value of the Minnesota code is performed.

○ axis deviation display

When Menu No. 6 is selected, axis deviation is displayed.

【0043】 ○ display of each wall

When Menu No. 7 is selected, each of front wall, side walls, rear wall, and

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bottom wall is simultaneously displayed. 5 levels of displays according to color shown in each wall below by the comment are shown.

1= yellow: normal      2= green: caution needed      3=blue: minor abnormal

4=pink: moderate caution needed      5=red: severe caution needed

Each of the walls can be selected and displayed in enlarged manner. The front wall, the side walls, the rear wall and the bottom wall can be selected and displayed.

[0044] ○ calculation value display

When Menu No. 8 is selected, each waveform value (average value) of the calculated leads obtained from the subject being examined is displayed. As an example, tables 4 and 5 shows calculated vales obtained by measuring a 25-year-old male The table 4 shows heart beat and the table 5 depicts amplitude of heart potential.

[0045]

[table 4]

[0046]

[table 5]

[0047] ○Deregistration of a subject being examined

Registration of the subject being examined is deleted by selecting Menu No.9.

○ A list of Minnesota code

A list of Minnesota code for a subject being examined is displayed.

[0048]

**[Advantages of the present invention]** As described in the above, the recording device of cardiac potential according to the present invention has

an advantage that functions of heart can be recognized visually and intuitively and can easily explain the functions to ordinary people for easy understandings without using conventional cardiograph equipment.

[0049] The cardiac potential recording device according to the present invention has the following advantages by displaying cardiac potential of the heart in different colors:

(1) Analysis of the waveforms can easily be recognized visually and intuitively by displaying cardiac potential visually and intuitively, while enabling observation of heart function.

[0050] (2) The subject's heart potential can be analyzed as clinical application of this invention, a heart function can be measured, and the diagnostic medical treatment progress in comparison with the reference value of the Minnesota code can be observed. In addition, based on such advantage, clinical inspection of the department domain of the heart is conducted, and from a normal person's waveform pattern, the cardiac potential of a measured person compares how much it is deviated, and can apply to inspection of work of the function of the heart of ordinary people and other domains not to mention medical treatment for people having heart problems.

[0051] (3) Since heart potential is displayed visually according to the color, measurements of waveforms can be conducted visually in correct manner. In which way, there is not much possibility to cause the measurement error by measurement person like before.

(4) Heart potential is automatically recordable using a program.

**[Brief description of the drawings]**

**[Fig. 1]**

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FIG. 1 is a block diagram illustrating an example of an electro cardiographic mapping of the present invention.

[Fig. 2]

FIG. 2 is a circuit diagram of an interface circuit.

[Fig. 3]

FIG. 3 is a diagram illustrating an example of a controller unit of an analog/digital converter.

[Fig. 4]

FIG. 4 is a flow chart of a recording method of electro-cardiograph mapping.

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**【Document name】 Abstract**

**【Abstract】**

**【Object】** It is an object of the present invention to provide a recording device of electrocardiograph by which functions of heart can be recognized visually and intuitively and can easily explain the functions to ordinarily people for easy understandings without the use of a cardiograph equipment.

**【Means to achieve the object】** A recording device of cardiac potential which comprises: electrodes attached to each of lead parts and an inducting cardiac potentials; an interface device converting analog signals into digital signals; and a personal computer for performing fetch of the digital signals and calculation of measurement data, and carrying out analytical expression of variation from a benchmark into a cardiogram.

FIG.1

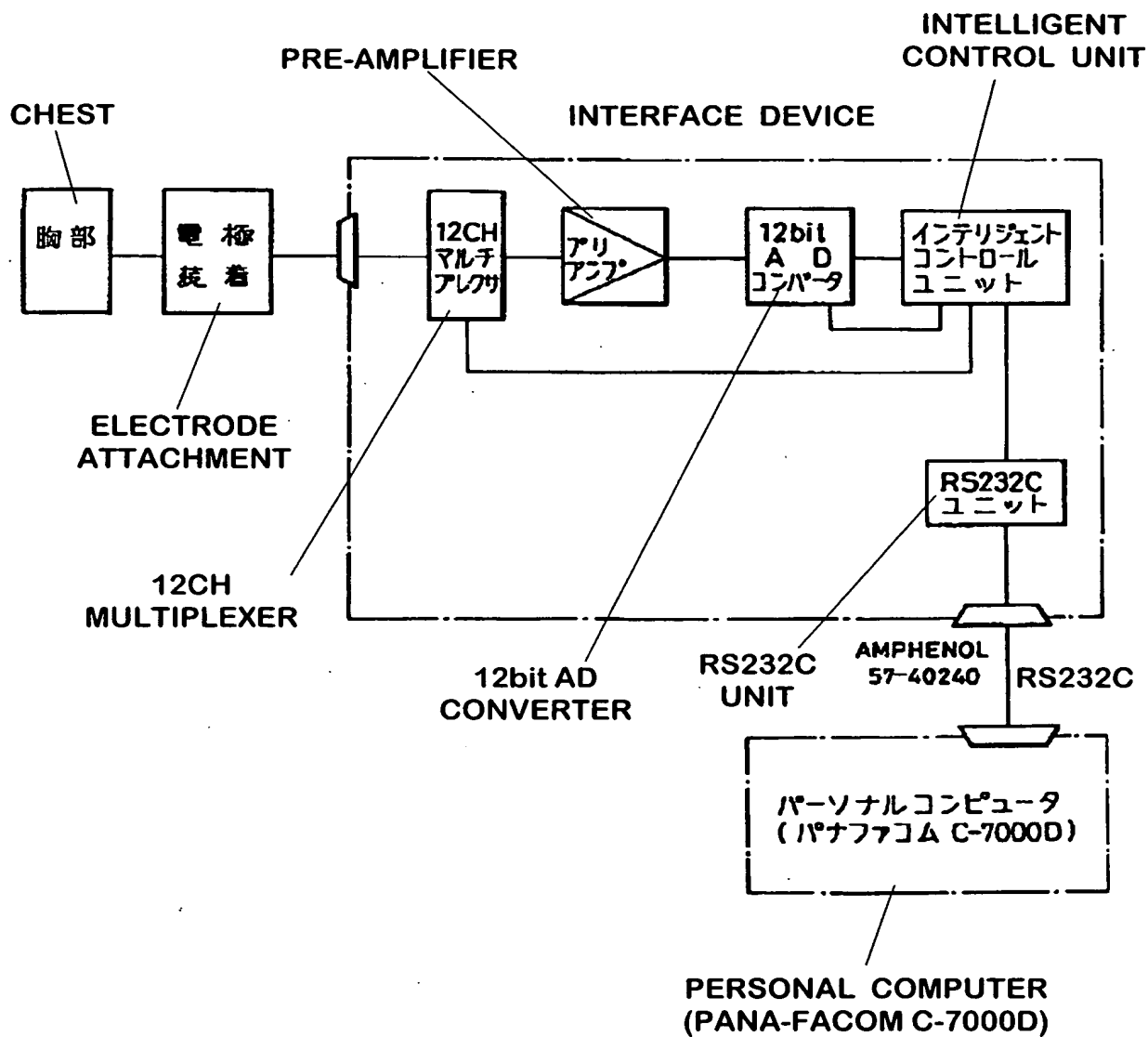
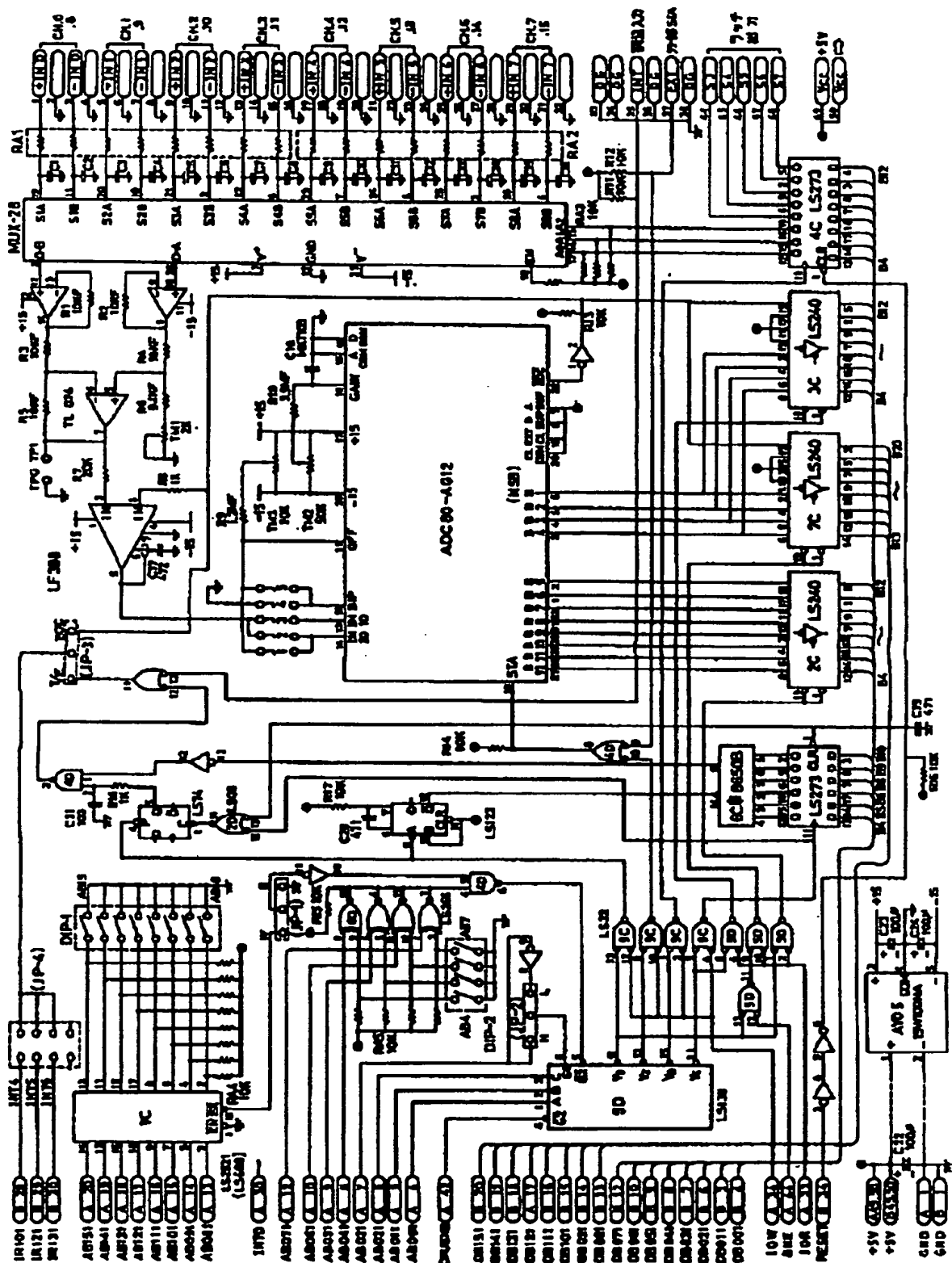




FIG.2



**FIG.3**

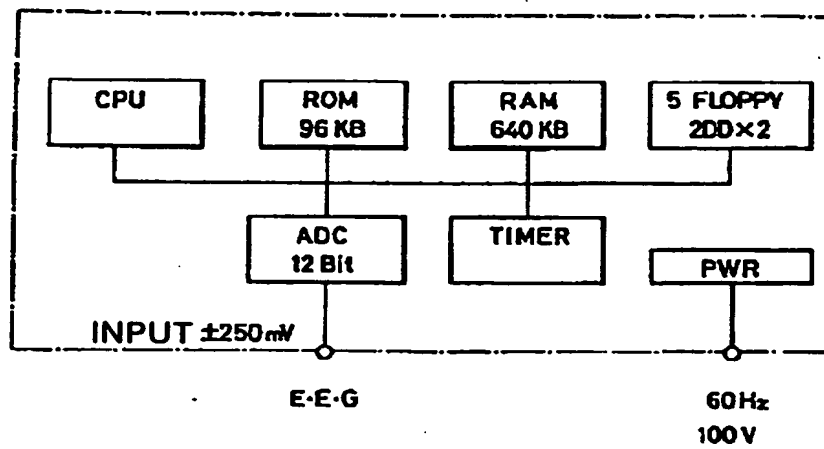
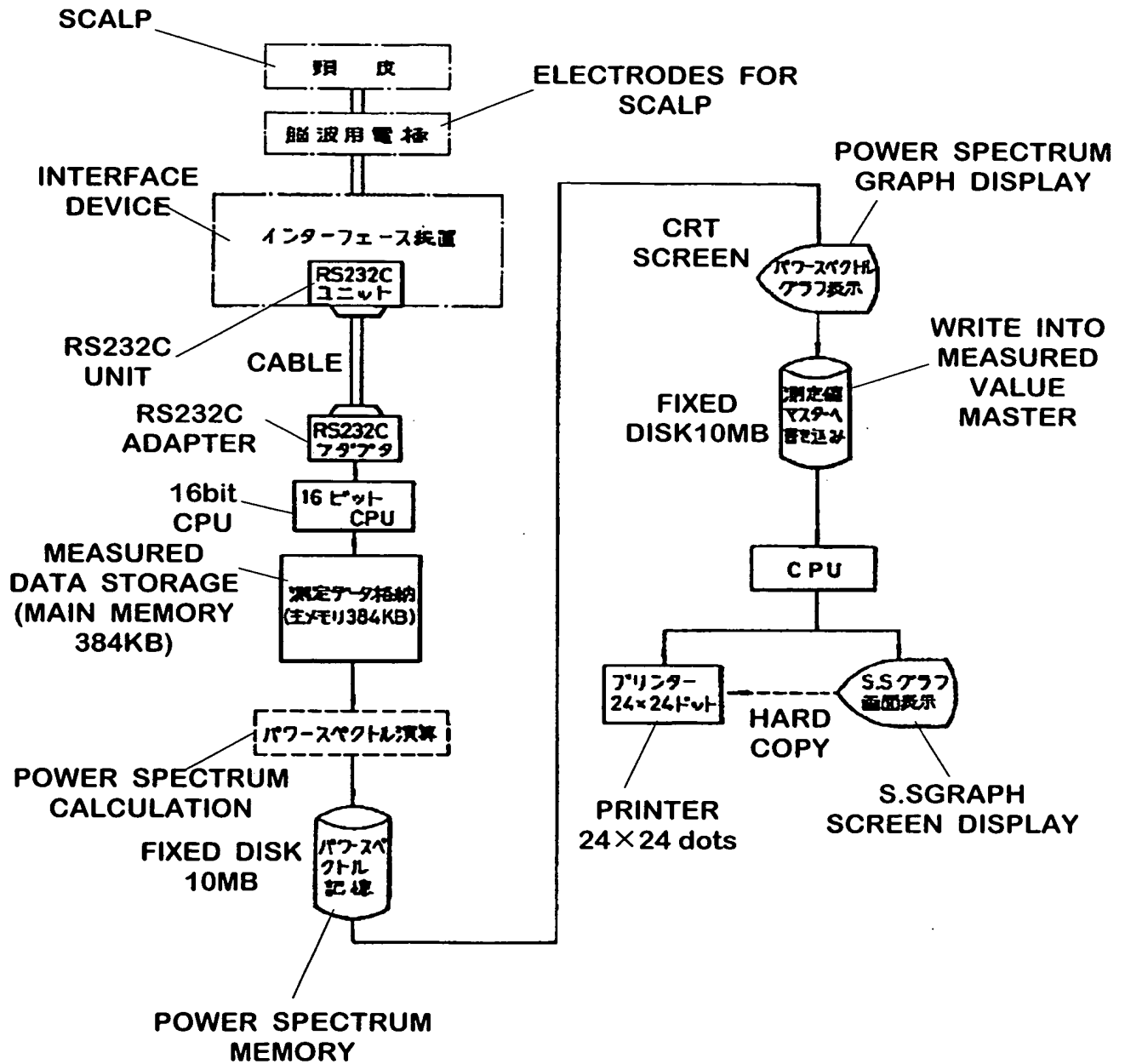


FIG.4



# TABLE1

Processing procedure	Processing steps
Registration of subject measured	Select menu No.1 and register the subject
Display of data on the subject  Start retrieval	Data on the subject is automatically displayed when menu No.2 is selected Start retrieval upon input of DATA OK Y/N Y
Display of original waveforms of 12 leads  Choice of waveform to be measured  Start measuring enlarged display of each lead of limb · chest	Contents of menu No.3 is automatically displayed upon finishing retrieval Selecting waveform to be measured with DATA OK Y/N Y and measure automatically Upon selecting menu No.4 measured waveform(1beat) with 12 leads is displayed
Enlarged display of each lead of limb · chest	Each lead can be displayed in enlarged manner

# TABLE2

Processing procedure	Processing steps
Display of diagnosis · comments so on	When menu No.5 is selected. Diagnosis that compares measuring values and reference value of Minnesota code and so on is displayed.
Axis deviation	When menu No.6 is selected. Axis deviation is illustrated in a pie chart.
Display of echocardiogram  Enlarged display of each of walls	When menu No.7 is selected. Each of walls are simultaneously displayed.  Each wall can be displayed in enlarged manner.
Display of measured value	When menu No.8 is selected. Time period(ms) of each wave for 1beat in each lead(12 leads) and amplitude there of(mV) are displayed.
Deregistration of subject being examined	Registration of subject being examined is deleted by selecting menu No.9.
List of Minnesota code	The list is displayed when menu No.10 is selected.

# TABLE3

Menu No.	Brief overview
1	Registration of subject measured.
2	Display of subject · start retrieving
3	Display of original waveforms
4	Display of calculated waveforms
5	Calculation result display
6	Axis deviation display
7	Display of each wall
8	Calculation value display
9	Deregistration of subject
10	List of Minnesota code

# TABLE4

LEAD	TIME/ m S											
	P	P'	Q	R	S	R'	S'	RR	PR	VAT	QRS	QT
I	93		21	45	29			625	153	41	93	341
II	93		21	53	29			625	149	49	101	373
III	77			69				625	165	33	69	285
AVR	97			21	49	29		625	153	73	97	369
AVL	53			13	57			625	97	9	69	273
AVF	93			69				625	165	33	69	353
V <sub>1</sub>	49	41		33	37	29		625	141	21	97	321
V <sub>2</sub>	61			41	57			625	149	29	97	297
V <sub>3</sub>	101			45	33	21		625	157	33	97	305
V <sub>4</sub>	101			61	25			625	165	41	85	325
V <sub>5</sub>	97		21	49	25			625	153	45	93	337
V <sub>6</sub>	61		21	57				625	117	45	77	313

TABLE5

LEAD	P	P'	Q	R	S	R'	S'	mV				
								ST <sub>0</sub>	ST <sub>1</sub>	ST <sub>2</sub>	T	T'
I	1.2		-0.7	6.9	- 2.3			-0.4	-0.2	0.2	1.5	
II	2.6		-0.8	19.3	- 2.4			-1.2	-1.0	-1.0	1.0	
III	1.7			12.9				-0.4	-0.8	-1.1	-1.8	
AVR	-1.6			0.9	-12.7	2.4		1.1	0.9	0.6	-0.8	
AVL	0.2			0.7	- 2.9			0.2	0.7	0.8	1.8	
AVF	2.2			16.1				-1.1	-0.9	-1.1	0.6	
V <sub>1</sub>	1.0	-0.2		3.4	- 9.7	2.4		1.2	0.9	0.8	-1.4	
V <sub>2</sub>	1.3			8.1	-22.5			1.1	2.1	3.2	5.4	
V <sub>3</sub>	1.6			12.1	- 4.2	10.6		-0.1	0.3	1.1	2.3	
V <sub>4</sub>	1.5			21.8	- 2.6			-0.8	-1.0	-1.0	-1.6	
V <sub>5</sub>	1.4		-1.0	20.1	- 2.1			-1.0	-1.0	-1.0	-0.5	
V <sub>6</sub>	1.1		-1.2	16.3				-1.5	-0.7	-0.7	-0.1	



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